Quantification of Biofuels Potential of Post-Soviet Countries in the Context of Global Biofuels Development

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Abstract. This paper provides an overview of biofuel's markets in Russian Federation, Belarus and Ukraine and it estimates prospects of their future development in the context of global biofuels development. We first provide a general characterisation of biofuels, followed by description of development of biofuel industry in the key selected countries and the outline of current trends on the global market. This is followed by a quantitative analysis of the possible development of biofuels in Russian Federation, Belarus and Ukraine.

Key words: Eastern Europe; Biofuels; Ethanol; Biodiesel

JEL classification: R11; Q16; Q42; P28

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Introduction

Renewable energy sources have been perceived as the solution for the number of global and national concerns. The oil crises and price shock from 1970s had prompted an interest in the adoption of renewable fuels, which unlike fossil fuels could regenerate. Thus liquid biofuels would contribute to the saving of decreasing fossil fuels reserves, constantly growing energy demand and energy security. Moreover, in the context of environmental protection, biofuel's provides lower negative impact on climate change compared to traditional fuels. In view of energy security and diversification, use of biofuels would minimize energy dependence of importing countries from the major producers and exporters of fossil fuels such as The Organization of Petroleum Exporting Countries (OPEC). By the same token biofuels would be the answer to excessive production of agricultural commodities, abandon land and would bring new opportunities for the local farmers. Despite rapid expansion of biofuels worldwide, this sector is considered relatively new and being in the continuous development and renovation.

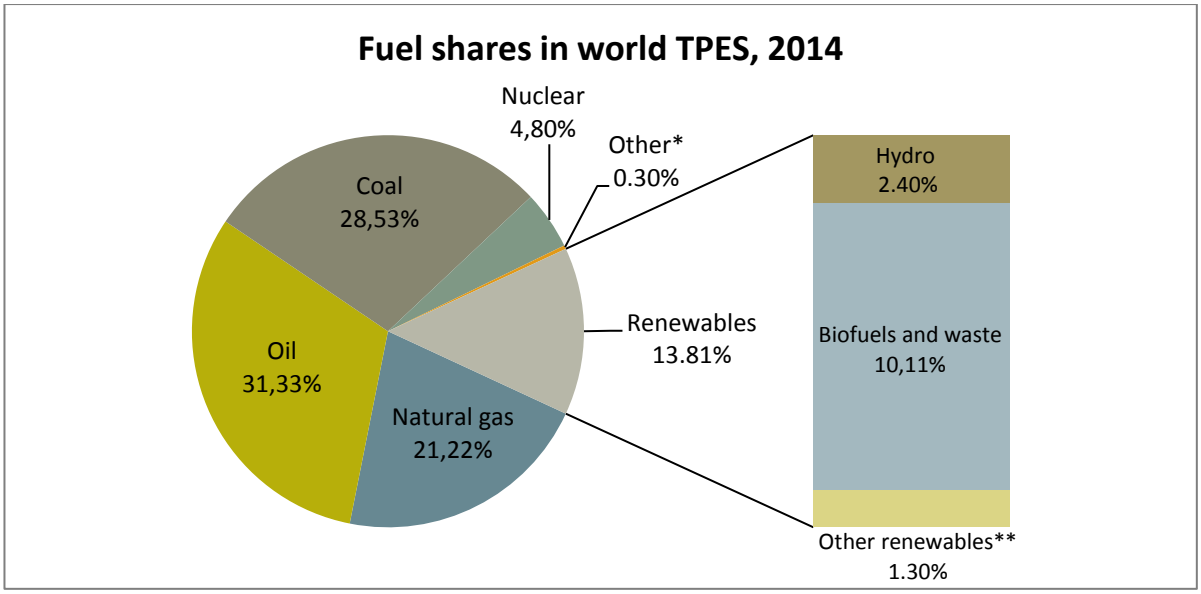
Prompted by increase in energy security and climate change many countries have decided to develop their own biofuel's industry. Thus having a comparative advantage such as arable land or feedstock availability plays significant role in the biofuel's market growth. For the purpose of this paper were selected countries, whose potential of biofuels is considered extensive but unevolved yet. Development of biofuels in Russia, Ukraine and Belarus has only begun and until recent years their potentials were poorly utilised.

We structure this paper in the following way. We first define the biofuels in regard of their sources and use. Then we talk about current trends on global biofuel's market, overview of biofuel policies in the key selected countries and incentives applied worldwide in this sector. After this we estimate the potential of an exported feedstock from Russia, Ukraine and Belarus and its contribution to the development of biofuel industry and achievement of established targets. This paper aims to contribute to the controversial debate on further development of biofuels in the post-soviet countries and provide reader with data and information that are difficult to obtain and usually available only in Russian language.

1. Introduction to biofuels

In recent years renewable energy sources and especially biofuels have been one of the most discussed topics in political as well as scientific, public and economic spheres. Biofuels are renewable alternatives to fossil fuels such as gasoline, coal and diesel in the sector of transportation. Continuous issues with the supply of energy sources and environmental impacts from traditional fuels have triggered the expansion of biofuels through extensive researches and developments (R&D). Generally development of biofuels had been driven by three key global challenges: energy security, economic development and mitigation of climate change. The International Energy Agency defines energy security as the uninterrupted availability of energy sources at an affordable price (IEA, 2016). Possible risks for energy security may cause disruption of imported energy supply or high energy prices environment. Thus opportunities for development of domestically extracted sources of energy became attractive for many countries largely dependent in imported fuels. In the view of economic development, as biofuels production capacities expand, they create new "green" jobs throughout the economy and new opportunities for income for local farmers. In the context of mitigation of climate change, nowadays fossil fuels represent not only major source of energy, but also main source of carbon dioxide emissions (CO2) and greenhouse gas (GHG). Biofuels such as bioethanol and biodiesel are not CO2 neutral, however they are considered to notably reduce emissions compared to diesel or gasoline.

Global economic growth has had significant impact to the increase of energy demand. As reported by U.S. Energy Information Administration (2016), energy consumption is projected to grow by 48% by 2040. And biofuels may contribute to the meeting these needs in a sustainable way. In 2014 world Total Primary Energy Supply (TPES) had reached 13,7 Mtoe, of which 13.81% were provided by renewable energy sources. Graph bellow represents global balance of TPES in 2014, where biofuels had peaked 10.11% in 2014.



*Other includes electricity generated from energy sources not defined in the graph: non-renewable wastes, peat, chemical heat etc.
**Other Renewables consists of geothermal, wind, solar and tide energy sources.

Graph 1: Fuel shares in world Total Primary Energy Supply, 2014

Source: Key Renewables Trends Statistics, IEA, 2016

Biofuels are defined as fuels derived from the biomass and produced by contemporary biological processes. Alike traditional fuels they exist in number of forms and categories and could also be classified into several generations (from the first up to the fourth generation). The differentiation of the biofuels is primarily based on three characteristics: the type of the feedstock, the conversion technology utilized and features of the fuel molecules. Nonetheless not all types of biofuels perform equally regarding influence of climate change, energy security and ecosystems.

1.1. **The conventional biofuels**

The conventional or the first generation biofuels refers to the fuels, which have been obtained from the material like starch, sugar, vegetable oil and animal fat. The most known representatives of the 1st generation biofuels are bioethanol, biodiesel, vegetable oil and biogas. However among liquid biofuels—mainly bioethanol and biodiesel—represent the vast majority of the renewable share ("Renewables 2015.Global Status report", 2015). The main difference from the second generation biofuels is in the feedstock used and volume of GHG. The 1nd generation biofuels could notably affect the food supply in case of large quantity

production. Another big disadvantage of the conventional biofuels is that the required crops are demanding in the usage of the several inputs such as land, water, fertilisers and pesticides etc., followed by implications on the environmental side (Ziolkowska & Simon, 2011).

In the beginning of 21st century the interest in biofuels production had globally significantly escalated, mainly in the food crops containing source of the biomass related to the first generation. Therefore nowadays the production of the conventional biofuels is represented by well-established and already developed technologies.

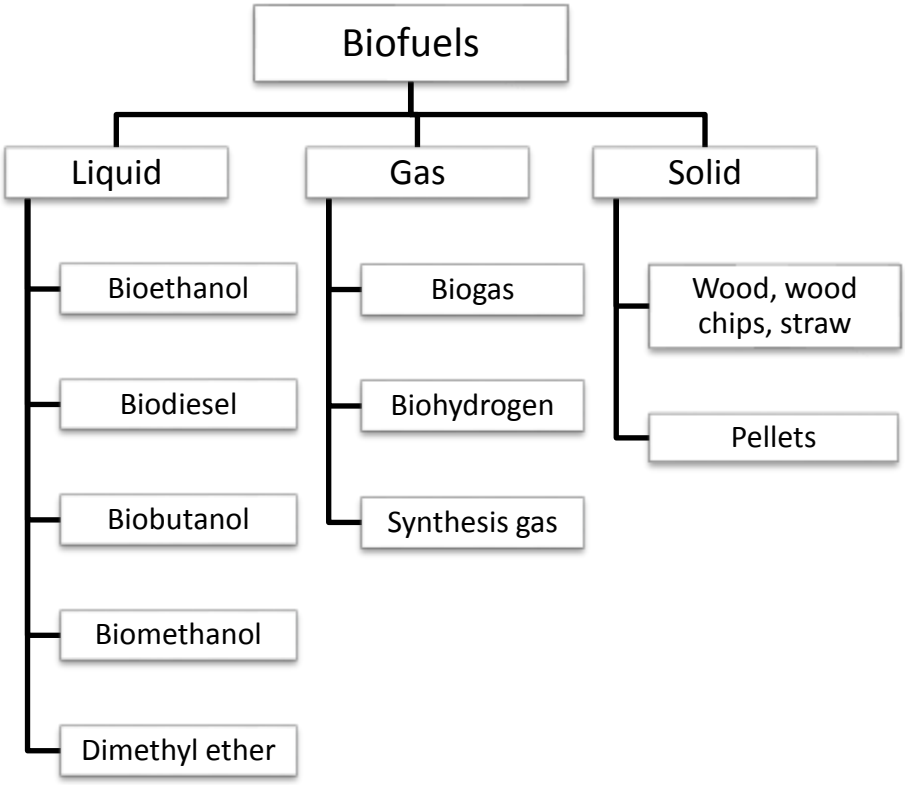
1.2. The advanced biofuels

Since the boom in the 1st generation biofuels, the focus shifted to the advanced biofuels which include the second and further generations. The main aspect of advanced biofuels definition is reduction of GHG emissions by minimum 50% compared to fossil fuels. Interesting to note, that the U.S. Environmental Protection Agency (EPA) considers Brazilian sugarcane ethanol as an advanced biofuel since it decrease greenhouse gases by 61% in comparison with traditional gasoline. As was mentioned earlier the 2nd generation biofuels are extracted from a different non-food feedstock, the food crops could only be used in production of advanced biofuels, if they were already used for food purposes, for the instance - the vegetable oil waste. Therefore the main source for the 2nd generation biofuels is wastes, energy crops, agricultural and forestry remains and algae. This generation of biofuels is considered to be “greener”, based on the sustainability of the feedstock, the greater reduction of GHG (greenhouse gas) emissions, its influence on the biodiversity and the land usage. Moreover advanced types contribute to the cost reduction in biofuels production in the long term than its predecessors. Nowadays modern industries pay attention to the organic waste as a new resource due to its re-use. European countries especially have been lately devoted to the waste management. Utilisation of lignocellulosic biomass provides high value usage of low value wastes, what lifts revenues for companies, processing residues flows.

The 3rd generation biofuels are extracted from algae and have gained a lot of attention only recently. It became quite popular because of the major advantage it is capable of – diversity. From algae not only biodiesel and some components of gasoline can be obtained, but also it could be genetically transformed for production of other numerous fuels directly, such as bioethanol and butanol. The fourth generation of biofuels are facing experimental stage

so far and aimed to provide not only sustainable fuel but also to absorb and store CO2 (Schmetz & Ackiewicz, 2009).

Table 1: Classification of biofuels based on state of aggregation



1.3. Liquid biofuels: closure look to bioethanol and biodiesel

Bioethanol

First generation bioethanol is made by distillation from the agricultural products containing starch or sugar, such as corn, grain or sugar cane. Production of conventional bioethanol can generate significant amount of by-products such as food gluten, enzymes, starch, bioplastic and fodder. In this regard bio-refinery plants are focused not only on the production of the bioethanol but big range of the additional products.

Cellulosic bioethanol is a 2nd generation biofuel and offer wider range of feedstocks to be obtained from. All different types of the lingo-cellulosic materials could be used for its extraction, which provide full usage of the biomass in the production of the bioethanol. Lingo-cellulosic material is obtained from variety of the sources, such as agricultural residues, paper

and municipal solid waste, wood, energy crops and fast growing plants that could be grown on non-arable land. Considering the world's experience, the most widely used methods of utilizing bioethanol are (ePure, 2014):

- As an additive to motor gasoline fuels in concentration of 5-15% (fuels E5, E10 and E15). For instance E10 contains 10% of bioethanol and 90% of gasoline and is applicable for automobiles with traditional gasoline engines. Bioethanol adds oxygen into gasoline blend, what contributes to minimizing an air pollution;
- In a mixture with up to 85- 100% of bioethanol (fuels E85, E100), for example fuel with 85% of bioethanol and 10% of gasoline is used in motors with the universal fuel consumption systems, so-called "Flex-Fuel" engines. But bioethanol contains less energy per gallon comparing to gasoline, what makes blends with higher addition of bioethanol less competitive on the market. In this regard E85 and higher blends should be sold with a discount in order to motivate sales (Babcock & Pouliot 2013);
- For the synthesis of the methyl tert- butyl ether (MTBE) which is used as high-octane component of the automobile's gasoline.

The "traditional" gasoline engines are suitable for E5 as well as for E10 and do not require additional modifications. According to the Ethanol Producer Magazine (2014), 40% of the Brazilian cars use mixture of bioethanol and gasoline fuel, in USA this share is much lower – 10%, and only 5% in Europe. In most EU countries became widely used E5 (fuel with 5% of bioethanol). And meanwhile the United States are already introducing E15 to the market, France, Finland and Germany recently started transition to E10 fuels (Ethanol producer magazine, 2014).

Biodiesel

Biodiesel is a renewable clean-burning diesel made by combining methanol (or other alcohol) and vegetable oil, animal fats or greases. Initial feedstock for biodiesel mechanical or chemical extraction includes rapeseeds, sunflower seeds, soy seeds and palm oil. However through development the material resource was broaden to animal fats, recycled cooking oils and greases. Biodiesel can be used in normal diesel engines as well as some blends in stationery heat and power applications. The downturn of biodiesel use is that fuel could gel under cold climate conditions. Biofuel may have poor cold flow characteristics depending on its quality,

the feedstock and on the additives. This feature brings risks into biodiesel utilization and its promotion, especially in the countries with cold climate like Russia

The most common type of biodiesel blend is B7 with 7% biodiesel. Regarding Sungate report (2015) the average blend within EU is 5,2% and limited to contain 7% of biodiesel and 93% of conventional diesel. In the USA the biodiesel as well as bioethanol mandates vary from state to state: in Illinois and Minnesota blends higher than B10 are common, in New York current standard is B5, Minnesota is planning to introduce B20 in 2018 (Minnesota Department of Agriculture, 2016) and for instance in Ohio the biofuels mandate was cancelled in 2015 on a state level. . New mandates for B10/B15 are technically feasible for several countries and already under implementation in Argentina (B10), Indonesia (B15), Malaysia (B10 for the transportation sector) and expected to be applied in Brazil within next 2 years (B10) (Biofuels Digest, 2016).

While bioethanol is more widely used in USA, in Europe the biodiesel is more popular. For instance biodiesel reckons 3% (2,8 Million tons produced in 2015) on the German market and only 0,15% (4,8 Million tons in 2015) in USA, which is the biggest producer of the biodiesel by country. The second largest producer is Brazil with 2,1 Million tons of biodiesel (Statista, 2016). Annually more than 9 Million tons of biodiesel are produced in EU by over 256 plants mainly located in Germany and France. Moreover it also reach 80% share on the transport biofuel market in EU which contribute the EU to be the leading consumer of biodiesel (ePure, 2015).

2. Characteristic of biofuel policies in the selected key countries

The rapid development and sustainable growth of the biofuel sector in many cases is primarily motivated by country policies and supportive regulations worldwide. The industry of the biofuels still being in evolving phase, it is lacking competitiveness compared to the traditional fossil fuels. However without a support from the governments, this sector wouldn't continuously develop worldwide over a past decade. In the next section we would like to provide a reader with a brief overview of biofuel policies in the selected key countries and current trends on global biofuel's market.

Based on the world's experience and biofuels market overview of the selected countries, for the successful development of the renewable energy sources, it is necessary to set up system of roadmaps aligned by supportive regulations, policies and targets. Policies, that include blending mandates and financial support from the government aligned with secured feedstock supply showed to be essential for the industry growth. Analysis of the policies in the field of renewable energy usage shows that common ways to stimulate investments in biofuels are:

1. Favourable taxation including tax reduction or tax exemption on biofuels for both sides: customer and producer. Biofuels produced commercially tend to have higher costs of production compared to fossil fuels. Moreover these costs are difficult to estimate because of dependency on feedstock prices, technology and other national factors. As a consequence some countries apply zero excise duty that favours production.
2. Legislative and policy framework including introduction of the energy standards, consumption targets (facultative) mandates (obligatory), which represent minimum share in total transport fuel, and such an incentive as Green Certificates (RECs). While application of targets is characteristic for Australia, China, India, Indonesia, and Malaysia, mandates widely used in the United States and EU. The mandates program requires oil companies to blend biofuels with the diesel and gasoline regarding specific mandate. Green Certificate (REC) is a non-tangible tradable energy commodity that represents the environmental value of produced energy from the renewable source. Opposite to traditional supportive programs and policies, certificate encourages biofuel use by providing subsidy for its production. Depending on the market, RECs could have a significant impact on the competitiveness (Osterkorn & Lemaire, 2008)
3. Specific credit lines with favourable conditions that attracts investments into the industry and other forms of financial incentives, including preferential loans and subsidies (Rajagopal & Zilberman, 2007). De Gorter and Just proved in their study ("Water" in the U.S. bioethanol Tax Credit and Mandate", 2008) that combination of the tax credit policy, which works as direct subsidy, with binding mandate is favourable not only for biofuel producers but also for consumers due to lower price

offered. However, if the tax credit is the only obligatory policy established, it does not benefit to the buyer;

4. Direct investments in R&D, technology and biofuels sector;
5. Trade measures, import tariffs in particular;
6. Well-developed infrastructure (transportation, water and electric systems, fuelling stations, etc.);
7. Intentions to stimulate biofuel production efficiency and development on different levels of marketing and supply chain (Blanco et al. 2010). For instance supportive measures in agriculture and encouragement of local farmers;
8. Existence of big experienced players on the market that have resources to invest in technology and promotion of biofuels;
9. For liquid biofuels technologies in the automotive and car industry are crucial. Vehicles, with the engines suitable only for standard-grade fuel, are relevant only for fuel blends with maximum 5% of biofuel. This is sufficient in the early stage of biofuel development, however for further development there is a need for implementation of modifications in engines and usage of higher blends;
10. The capability to create a long-term strategy and accomplish it by continuous development.

2.1.USA

Governments in United States provide various types of support policies on different levels, beneficial to biofuels and renewables in general. Nowadays US policies include mandates along with tax credits, preferential loans and funding of R&D as well as construction of bioplants. Diversified government initiatives have substantially contributed to the leader status in production of bioethanol for the last 5 years: United States along with Brazil, jointly accounted for 85% of global bioethanol production nowadays (Renewable Fuels Association, 2015)

The USA had already started establishment of biofuel policies in 1978 with Energy Tax Act which established tax exemptions and subsidies for a bioethanol blending in gasoline. In 2004 the excise tax exemption was replaced by tax credit for bioethanol and biodiesel that had been extended afresh in 2014 and currently presents the largest subsidy to biofuel producers (RFA, 2016). The main biofuel credit at the moment is The Cellulosic Biofuel

Producer Tax Credit, which allows producers of fuel that was extracted from specific types of cellulose to receive $1.01 per gallon back as a tax credit. In the recent past it was also extended to algae fuels, and of $1 per gallon for biodiesel. Moreover tax credit can be passed further to the consumer in a form of lower price.

Besides, Energy Policy Act initiated binding mandates in 2005. The first renewable fuel volume mandate was introduced by Renewable Fuel Standard program (RFS) and determined the minimum volume use of biofuel in the sector of transport. Since then, the mandate was expended twice: adding the biodiesel mandate along with raising the required annual use of biofuel in transportation to 9 billion gallons in 2008, growing to 36 billion gallons in 2022. In order to contribute to an expansion of the second and higher biofuel generations, mandate for 2022 establishes the requirement of a minimum 22 billion gallons for advanced biofuels and limits conventional biofuels to maximum of 15 billion gallons.

2.2. Brazil

Brazil was one of the first countries, which have developed sustainable biofuel economy. First policies, supporting bioethanol production, pioneered as early as 70s in National Bioethanol Fuel Program (part of National Alcohol program - Proalcool) in response to oil crisis. Proalcool back then was the world's largest program promoting alternatives to traditional fuels and obliging the use of bioethanol extracted from sugarcane. Expansion and development of bioethanol industry in Brazil is a result of successful bioethanol Fuel Program implementation that led the country to the worldwide second place in bioethanol production (7,093 Millions of gallons in 2015).

Since 90s till nowadays the government of Brazil does not control bioethanol sector directly nor over the production volume, nor through price settlement, but manages regulation over mandates and tax benefits. Since 1977 government employs bioethanol use binding mandate, which was renewed lastly in March 2015. The new blending obligation settles higher bioethanol share – 27% instead of 25%, but the increase is mandatory only for regular gasoline, conditions for premium gasoline don't change. Tax incentives for bioethanol fuel include tax reduction of Contribution for Intervention in Economic Domain (CIDE), Contribution to the Social Integration Program (PIS) and Contribution for Financing Social Security (COFINS) to zero and tax credits. Tax credit of 0,3% for bioethanol exporters was applied from 2014, what cheapens Brazilian export and partially pays a devaluation of an exchange rate. In 2015 the

government in several states of Brazil raised Tax for Circulation of Goods and Services (ICMS) on gasoline whereas reduced it for bioethanol what encourages its consumption. Besides for flex-fuel vehicles tax burden is usually lower in comparison with fossil fuel powered cars. Import tariffs were cut to zero from 2010 till nowadays. What's more National Bank for Social and Economic Development (BNDES) offers special credit lines for bioenergy sector as well as bioethanol industry to finance investments into production capacity enlargement and supply chain.

The development and expanding of Brazilian biodiesel market have been started much later then bioethanol, however government pays a lot of attention to promotion of biodiesel. First 2% biodiesel blending target was introduced in 2008 and current obligatory mandate already reaches 7%. As opposed to bioethanol, import tariff for biodiesel is fixed at 14%. The taxation of biodiesel is also more complex and depends on the feedstock, size of producer and region of production. Earlier in 2014 Brazil introduced advanced biofuels to the market, nonetheless due to expensiveness of the technology and enzymes used, the large scale production seems to be unrealistic yet (Barros, 2015).

2.3. EU

In a drive to cut emissions of carbon dioxide, the European Commission came with the Directive 2009/28/EC, which promotes different types of renewable energy sources including biomass. The Directive settles mandatory targets for each country for the share of renewable energy in overall energy consumption and separately in the sector of transport. Furthermore along with Fuel Quality Directive (FQD) it lays down the criteria of a sustainable production of biofuels and bioliquids. Members States are obliged to follow a roadmap and met a target of 27% share of renewable energy from final energy consumption by 2030. The Commission has highlighted need for a focus on advanced biofuels and no public support for a food-based alternative energy sources (European Commission: 2030 Energy Strategy, 2016). According to the Directive 2003/30/EC and Directive 2003/96/EC, entities, that use blends of biofuels in fossil fuels, can apply exemption from EU's minimum excise tax during 6 years period. Moreover Member States can settle national tax benefits separately after EU approves their incentives.

The EU had been producing 90% of the world's biodiesel before 2005. Regardless the fact that USA and Asian producers entered the market followed by decline in the European share, EU stays the world's biggest producer and consumer of the biodiesel.

2.4. China

China has recently become one of the global leaders in production of biofuels and ranks on a third place in production of bioethanol after US and Brazil. Biofuels market development is mainly driven by the goal of GHG reduction since China is world's largest emitter of GHG . According to Statista portal, China contributed to 28,3% share of global energy-related CO2 emissions in 2015.

Chinese biofuel policies are focused on supporting non-grain based biofuels due to the risk of possible grain shortage and China turning into a net corn importer. The government had set its current ambition in 2014 under National Climate Change Plan (NCCP). It had become already 13th Five Year Plan launched later in 2016. The plan settles emission and clean energy targets for 2020 including reaching 130 billion cubic meters of biofuel production by 2020 (approximately 34 trillion gallons). However the target seems to be unrealistic due to the current volumes of production and it stays uncertain how Chinese government plans to achieve the goal (Su &Zhang, 2015).

China, similarly to US, adopted bioethanol blend mandate (E10) in its 6 provinces: Heilongjiang, Jilin, Liaoning, Henan, Anhui, and Guangxi. Meanwhile the price of bioethanol is fixed by the government at 91.1% of the gasoline ex-factory variable price. However government does not have an incentive to determine E10 as national binding mandate in the nearest future because of its aversion to grain-based biofuels and lack of alternative feedstocks. Another unfavourable condition for domestic biofuel production is no tax benefits, it is charged by five% consumption tax. In 2012 China cut off import tariffs for bioethanol with selected countries and keeps free trade agreement (ten ASEAN countries plus Pakistan, Chile, Singapore and Vietnam). For other countries the 5% tariff is applied.

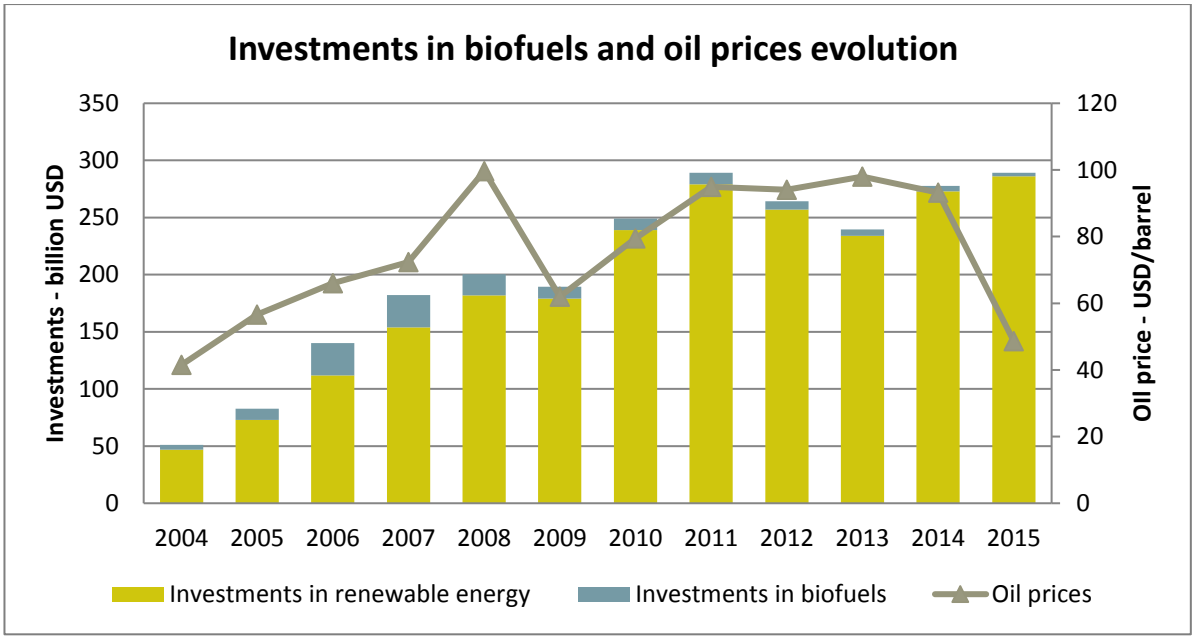
On the opposite side, Chinese production of biodiesel is currently very limited even though there is constantly growing demand for it (Caleb O'Kray & Kang Wu, 2010). The government efforts to support its production have form of exemption from excise duty.

Nonetheless no mandates were established so far and only a few biodiesel plants managed to stay in business, many of them became unprofitable.

2.5. Current trends on global biofuel market

While countries all over the world are working on the development of sustainable biofuel economies, each for their own reasons, United States and European Union are debating about impacts of 1st generation biofuels on the environment. The argument of the negative influence from conventional biofuels on food supply, biodiversity, land use and water was especially in the center of attention after world's food price crisis in 2007-2008. Meanwhile unpublished report from the World Bank claims that, food products could cost up to 75% cheaper, if not production of biofuels (Chakrabortty, 2008). Nonetheless concerns about conventional biofuels led some governments to revise their ambiguousness and targets for next years and shift focus onto advanced biofuels.

After series of challenges facing biofuel's market including mentioned food crisis and rise of feedstock prises, it is necessary to mention current lower oil price environment and its impact. The recent drawdown in oil prices to five years minimum was the last negative influence on global renewable industry in the recent years. As shown in the Graph 2 below: investments into biofuels have followed decreasing trend for the five years, from 10.3 billion USD in 2011 to 3.1 billion in 2015. However the biggest slide in the investments took place in 2015 caused by drop in oil prices. Investments had declined by 34% in comparison with the previous year and reached only 1% shares in the total renewable energy investments. According the Medium-Term Renewable Energy Market Report (IEA, 2015) the negative effect on the sector of biofuels seems to be overestimated in comparison with reality. Oil usage in energy production is quite limited in the power sector, but utilization in transport and for renewable heat extraction is the same as biofuels. This makes them competitors in latter. The interest in biofuels depends more on the government's leaning towards strengthening legal support and market's structure in this industry.



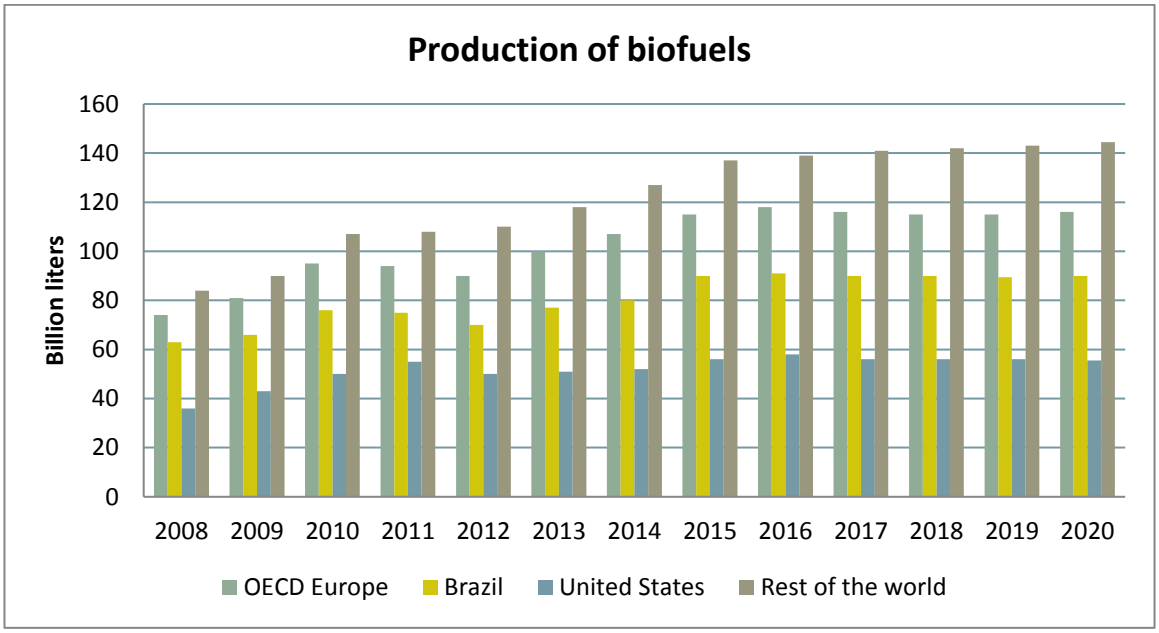
Graph 2: Investments in biofuels and oil prices evolution 2004-2015
Source: UNEP, 2016; Statista, 2016; EIA, 2016

Mandates and government's policies in general have evolved in the key markets over recent years. Brazil has raised both biodiesel (7%) and bioethanol (27%) mandates as was mentioned earlier in the paper. To support local producers, governments of Argentina and Indonesia decided to increase the blending mandate for biodiesel up to 10% as well. Actually drop in oil prices partially have had a positive effect on biofuels, because of fossil fuel subsidies abolishment in several countries. Meanwhile there are still risks challenging the biofuels growth. Potentially continued low oil prices conditions will place development of biofuel's policies under critical observation. The industry has already dealt with structural obstacles in stagnating bioethanol demand in the United States; meanwhile EU announced 7% cap on the first generation biofuels share in the 10% target for RES used in transportation for 2020.

The biggest challenge facing biofuels nowadays is shortage of investments into research and development of new generation technologies (Bland, 2015). Especially it concerns the feedstock, whether food or non-food based. The amount of feedstock for biofuels is normally 15-20 times lower than is required for chemicals production. Therefore the aim is to produce with low costs with secured feedstock supply (Bari, 2014). This area requires extra attention from the technology developers in the nearest future and we could already see some of them going out of the business. Recent example was BP's announcement in 2014 to halt cellulosic bioethanol business and sell out its related assets. Strategic decision was made after

investments over $750 million since 2008, pushed by the challenging external environment of low oil prices (Tullo, 2014).

However International Energy Agency in its Renewable energy medium-term market report (2015) estimates biofuels production for the next four years to remain stable, see Graph 2. In 2015 worldwide production had achieved the slowest growth rate of 0.9% since 2000 (BP Statistical Review of World Energy, 2015). But despite low oil prices, blending mandates hold biofuels consumption and production on the same levels in the sector of transport. In this regard production of biofuels did not experienced noticeable drawdown even in 2014: biofuels contribute to 4% of global road transport fuel and production volumes reached 127 billion litres. The forecast for to 2020 remains 144,5 billion litres and biofuels growth is expected to reach 4,3% share in transportation.



Graph 3: Production of biofuels and forecast to 2020

Source: Renewable energy medium-term market report, OECD/IEA, 2015

In line with the industry prosperity, forecasted by OECD/IEA, the majority of biofuels growth is foreseen to come from Asia and South America regions, which are still enthusiastic in asserting volume targets. The situation on biofuel market in America and Europe is quite different. Consumption there is motivated by legislation, which is continuously changing. And uncertainty about future changes in the policy framework brings much higher risk for renewables in general. There is still a room for strengthening the policy support, which is also risk prone to decline in oil prices. Therefore for these markets, it is vital to clarify the energy

strategy and develop sustained long-term policy commitment, which brings confidence in future investments and secures growth in biofuels industry (Bland, 2015).

3. Analysis of potential and future prospects of biofuels in Russia, Ukraine and Belarus

Consumption and related development of biofuels in the country generally depends on numerous crucial determinants including legislation, infrastructure and feedstock availability. In the analysed countries, an establishment of biofuel industry is even more complicated due to the lack of modern technologies, reliance on traditional sources of energy and risks from unsuccessful biofuel's market formation, nonetheless they are well provided with the feedstock.

According to the Doku and Di Falco (2011) study, land availability is more significant as a driver of biofuel policy than impact of GDP for the developing countries. In opposite way, GDP is crucial factor for OECD countries while impact of land availability is insignificant. Countries, selected for analysis, have originally promising comparative advantages for the development of biofuels. Thus naturally endowed in the land factor, Russia, Ukraine and Belarus have a precondition to be successful in the sphere of biofuels. Taking into the account only conventional types of liquid biofuels and relevant feedstock, investigated countries have high availability potential in at least three out of six most promising crops for production, as shown in the Table 2. In fact Russian Federation is 3rd in the world in wheat production (exported 30 thousands kt in 2015), Ukraine is 7th (10.9 thousands kt exported) and Belarus is 22nd (35 kt exported). These countries also have placed within ten biggest producers of rapeseed oilseed (Ukraine–6th place, Russia-7th and Belarus is 9th). Availability potential is considered high if production of selected crop is sufficient for the domestic consumption and excessive volumes are being exported.

Table 2: Feedstock availability for producing biofuels in Russian federation, Ukraine and Belarus

	Feedstock for bioethanol			Feedstock for biodiesel		
Country	Wheat	Sugar beet	Maize	Rapeseed	Sunflower	Soybean
Russian Federation	H	L	H	H	H	H
Ukraine	H	L	H	H	H	H
Belarus	H	H	L	H	L	L

H - high availability potential; L - low feedstock availability for biofuel production

Most of crops, exported from Russian Federation, Ukraine, and Belarus to the EU are used for further processing into biofuels. In this regard we would like to calculate the potential of exported crops and contribution it could bring to the balance of each country's TPES. We would like to analyze the potential only for the six crops, which have high potential for the investigated countries. Thus sugar beet will not be considered for Russian Federation, same as for Ukraine and maize with sunflower and soybean for Belarus. Due to lack of official data for each of these countries and difficulties to find required statistics in one place, we have compiled the table below from a number of different sources, which were used above in the work.

3.1. Biodiesel and bioethanol potential from exported feedstock

For biodiesel, the calculation of "Total oil export" is taking into account the export of specific crop oilseeds as well as export of extracted oil from this crop. Annual data for both indicators are available for Belarus at BELSTAT, for Ukraine – UkrAgroConsult and Russia – GAIN reports (2016). As in case of Belarus, rapeseed oilseed is not being exported in the opposite to rapeseed oil. To estimate percentage of oil in the crops yield and biodiesel in oil yield data from the study of Shrestha (2012) were used. The content of oil in the crop represents the maximum amount of oil that could be extracted. In addition the extraction should be processed by solvent, since mechanical extraction will contribute 10% in the form of food.

Table 3: Biodiesel potential from the exported crops and oil in Russia, Ukraine and Belarus, 2015

	Russian Federation			Ukraine			Belarus
Feedstock crop	Rapeseed	Sunflower	Soybean	Rapeseed	Sunflower	Soybean	Rapeseed
Exported amount of crop (kt)	2000	60	350	1416.5	0.789	1484	-
% of oil yield	48-52%	40-50%	17-25%	48-52%	40-50%	17-25%	48-52%
Export of extracted oil (kt)	240	1446	415	152	4000	122	133
Total oil export (kt)	1240	1473	489	860	4000	434	133

Conversion rate (L/t)	1082	1087	1080	1082	1087	1080	1082
Biodiesel potential (10^6 l)	1342	1601	528	931	4348	468	144
Biodiesel potential (ktoe)	1015.38	1211.75	403.36	704.59	3290.85	354.40	108.91
Share of TPES per crop	0.15%	0.17%	0.06%	0.56%	2.62%	0.28%	0.39%
Share of TPES per country	0.38%			3.47%			0.39%

Biodiesel potential (in litres) is estimated, using conversion rate that represents how many litres could be produced from 1 tonne of extracted oil. In order to be able to measure the contribution of biodiesel potential from the exported crops to the balance of TPES, we need to convert litres to the tonnes of oil equivalent. First step is to transform volume of biodiesel to the mass units of measure, using density, which is equal to 0.880 kg/L for biodiesel. Next step is to evaluate the energy content by multiplying tonnes of biodiesel potential by 0.86 toe (1 t biodiesel = 0.86 toe). Because of unavailability of TPES data for year 2015, for an estimation of biodiesel share in the TPES, its average level for the last ten years was taken.

Table 4: Bioethanol potential from the exported crops in Russia , Ukraine and Belarus, 2015

	Russian Federation		Ukraine		Belarus	
Bioethanol	Wheat	Maize	Wheat	Maize	Wheat	Sugar beet
Export (kt)	30000	12500	10900	321	35	1600
Conversion rate (L/t)	390	410	390	410	390	80-100
Bioethanol potential (10^6 l)	11700	5125	4251	131.61	13.65	144
Bioethanol potential (ktoe)	5908.0	2587.9	2146.6	66.5	6.9	72.7
Share of TPES per crop	0.85%	0.37%	1.7%	0.1%	0.02%	0.26%
Share of TPES per country	1.22%		1.8%		0.28%	

Similar analysis was done for the bioethanol production from the wheat, maize and sugar beet. Exported amounts were converted to bioethanol potential in litres, based on the rates from the Ukrainian Scientific Research Institute of Alcohol and study of Patni, Pillai and Dwivedi (2013). Litres of bioethanol potential measured in units of mass are calculated, using density of bioethanol- 0.789 kg/L. Energy content for bioethanol reaches 0.64 toe/t, which is lower than for biodiesel. Than bioethanol potential, measured in kilo tonnes of oil equivalent is investigated, considering energy content. As in previous calculations for biodiesel, share of

bioethanol per crop and country took into account average TPES during recent decade (see Table 3, 7, 13).

Table 20: Total bioethanol and biodiesel potential per country, 2015

Potential production (mtoe)	Russian Federation	Ukraine	Belarus
Biodiesel	2.6305	4.3498	0.1089
Bioethanol	8.496	2.213	0.0958
Total	11.126	6.5629	0.2047
Total % of TPES	1.6%	5.2%	0.7%

Based on the estimation of biofuel potential from the exported crops, Ukraine has highest revealed potential in the balance of TPES for both bioethanol and biodiesel among three selected countries. It is leading in the potential production of biodiesel with the main input from sunflower oil. In 2014 Ukraine has imported overall 34.4 mtoe of different types of energy sources including natural gas (16 mtoe), coal (10.3 mtoe), oil products (8.2 mtoe), crude oil (0.2 mtoe) and biofuels and waste (0.02 mtoe) (IEA, 2016). Based on provided estimations, revealed potential of bioethanol and biodiesel would bring additional 5.27% to the TPES. Thus Ukraine would be able to achieve approximately 7.1% of Biofuels and waste in the balance of TPES including current share of 2014. In this regard Ukraine would reach highest share of biofuels and waste in the energy balance among analysed countries. Average final consumption of energy in the sector of transport from 2005 till 2014 was 12.7 mtoe (in 2014 - 10.3 mtoe). In this regard approximately 6.6 mtoe of biofuels, which being exported in the form of crops, could potentially cover almost half of needs in the transportation (51.7%) and substitute imported energy sources.

Draft of Energy Strategy of Ukraine until 2035 created by National Institute for Strategic Research, which targets were approved by NREAP, projects to reach 13.1 mtoe of biofuels and waste in 2035 (see Table 11). Despite the fact that both drafts of ES are currently being under discussion and awaiting for confirmation, we assume accepted ES would not differ significantly from the existing drafts. Considering contribution to achievement of target established in the ES: potential from exported feedstock would help country to reach 50% from the 2035 objective. Taking into the account 2014 level of domestic production of biofuels and waste (2.383 mtoe without net export) and investigated potential volumes, Ukraine would manage to attain around 8.95 mtoe that account for 68% from the planned goal. Draft of ES also contains targets for use of biofuels in the sector of agriculture-9.3%, transport-4.5%, food

industry-6.9% from gross final consumption of 4.9 mtoe. In spite of feedstock availability, implementation of settled targets would depend primarily on reduction of excise tax for biofuels and its synchronization with European excise law.

Despite low contribution of analysed biofuel's potential to TPES, Russian Federation would gain from the exported feedstock 11.1 mtoe of biofuels in 2015, what is almost twofold higher than Ukraine. However compared to the Ukraine, these volumes would not significantly contribute to the Russian energy supply since their share would reach only 1.6%. Together with current share of biofuels and waste in the balance of TPES it would provide 2.6% supply. Last version of Energy Strategy until 2035 does not include a quantitative object for biofuels and generally Russia does not have any obligations to accomplish in the sphere of renewables. Apart from large-scale hydroelectricity, renewables in Russia are still in the early developing phase. As confirmed by European Parliament report (Russia's domestic energy policy, 2016), even if all planned projects to be implemented, share of renewables and therefore biofuels would remain meagre. Thus involvement of exported feedstock potential won't bring notable change into sector.

Belarusian potential in selected biofuels prevails in biodiesel production given by the exported amounts of rapeseed oil. Investigated potential would provide balance of TPES with only 1.09 mtoe of biodiesel and 0.96 mtoe of bioethanol (in total 0.7% of TPES). If share of biofuels and waste remains the same as in 2014 (5.3%), Belarus would reach not less than 6% by utilization of its potential from the exported feedstock. It will also lead Belarus to a decision to reduce its energy sources imports by 2 mtoe (40.5 mtoe in 2014). Regarding energy needs in transportation, the estimated amounts of biodiesel and bioethanol would cover around 50% of needs in that sector (based on average energy consumption of 3.7 mtoe during period 2005-2014).

Strategy for energy potential development in Belarus established a target of 2 mt as a minimum use of biodiesel and bioethanol by 2020. During analysis was revealed potential of 0.15 mt of bioethanol and 0.13 mt of biodiesel that would be enough to cover 14% of the Strategy objective. In the view of 2014 production of liquid biofuels (0.28 mt) Belarus would be able to reach 28% of its target by usage of exported raw materials domestically for further biofuel extraction.

3.2.Future prospects of biofuels in selected countries

Nowadays growth of biofuel markets is considered to be strongly connected with enacted biofuel policies, crude oil prices and macroeconomic environment. Table 5 summarize policies established in the selected countries. .Based on the experience of biggest biofuel producers, minimum mandatory share of biofuels in the transportation supported by tax reliefs proved to be most efficient policies. None of three countries has settled mandates or any other obligatory objectives in the sector. Besides none of analysed countries have a government body that would track execution of biofuel market policies together with projects, financed by government or foreign investments in the framework of international collaboration.

Meanwhile Ukraine, compared to others, has placed more powerful incentives; it has the same impediment as Russia in the form of high excise tax for bioethanol. Recently Ukraine was facing a dilemma: the government had been actively promoting biofuels and at the same time price gap and high demand from EU has triggered increase in the rapeseed production for the export. Therefore while low oil prices trend continues, export of raw materials abroad and cheap import of energy sources is more profitable for Ukraine compared to development of biodiesel production.

Table 5: Biofuel policies applied in Russia, Ukraine and Belarus

	Country	Russia	Ukraine	Belarus
Regulatory policies	Feed -in tariff	NA	A	NA
	Biofuel obligations/mandate	NA	NA	NA
	Tradable REC	NA	NA	NA
	Standardisation	A	A	A
Fiscal incentives and public financing	Capital subsidy/ grant	A	A	A
	Investment/ production tax credits	NA	A	NA
	Tax reliefs	NA	A	A

*A – Applied, NA – Not Applied

If not for low oil prices environment, Belarussian and Ukrainian policy gaps may be improved within current policy frameworks, whereas Russia may require the development of new legislation approaches. Meanwhile EU had recently shifted their focus to the advanced biofuels and in the nearest future will change their policies of no support for a food-based alternative energy sources. In spite the fact, that EU had been major importer of feedstock for biofuel production from Ukraine, Belarus and Russia, it inevitably will lead to the fall in countries oil and crops export. Hence countries could foresee the export crisis and reverse the

exported feedstock toward domestic conventional biofuel extraction sufficient for the early development stage. However for Russia there is a chance to leapfrog directly to advanced biofuels, since undertaken efforts proved to be incapable to integrate agricultural and energy sectors. Growing demand of EU in biofuels followed by increasing amounts of imported wood pellets keep Russia encouraged for the expanding production of solid biofuels. Russia became third biggest importer of wood pellets to European countries, after USA and Canada (USDA, GAIN Report, 2016). Meanwhile biodiesel and bioethanol could be interesting only in sense of further export, usage in rural areas, reduction of GHG and diversity, what have never been Russian focal points. Thus in the sphere of liquid biofuels Russia has never had clear objectives, proposed incentives were not ambitious and probably remain the same based on the government approach to related topics.

Ensuring energy security was considerable reason for the initial setup of biofuel policies especially for Ukraine and Belarus. Development of biofuel and renewables in general will have an impact on energy security of all three countries in various ways. Since they have vast sources of feedstock for production of biofuels, the result will depend mainly on the oil prices, policies and investments into R&D of new technologies. Meanwhile current low oil prices do not favour short to the medium-term development of biofuels. In these circumstances questions of energy security get lower priority. However in this environment is necessary to prevent risks from long term point of view. From the perspective of security supply, main benefit of development of biofuels is sustainable utilization of energy resources. That would ensure supply of energy flows, including traditional sources and renewable, for a long period of time. In the terms of security, energy balances of Ukraine and Belarus face bigger issues than Russian. They are considerably volatile because oil and natural gas remain major imported energy sources. Oil products provide up to 85% of energy consumption in transportation and supply is focused in a few countries such as Russia with problematic economic and political environment affecting their stability. Risk caused by vulnerable trade of traditional fuels had already encouraged many countries to support of their own sector of biofuels through regulatory and fiscal policy incentives. Belarus and Ukraine as well need to overcome their energy dependence by expansion of biofuels industry in order to increase diversity, making their economies less sensitive to external disturbances.

Conclusion

During last 15 years there have been waves of interest in biofuels as major producers have been concerned by oil prices, sustainability, environmental impact and other global issues. Many countries have intensively supported their biofuel's industries with ambitions for higher energy security and mitigation of climate change. Their active expansion was prompted mainly by efficient policies and incentives placed through whole supply chain from producer to the consumer. Government policies have set floor for production and price of biofuels that remain rather stable even in the low oil prices environment.

For some countries biofuels became universal solution to the range of national problems from agricultural overproduction to the energy dependence on imported fuels. However for a long time Russia had stayed aside from the global biofuel euphoria. Energy efficiency, diversification and utilization of extensive agricultural commodities had encouraged Russia to support alternative fuels despite vast naturally endowed energy sources. Significant availability of feedstock, arable land and production capacities favor Russian intentions. In 2006 Russia has joined biofuel development with numerous strategies, supportive programs and international projects including subsidies from International Finance Corporation. Nonetheless without any obligations and following sanctions, Russian government has proved its incapability to accomplish developing incentives. Strong oil and gas lobby, that is closely supported by government may play significant role in fulfillment of biofuel projects. Further analysis has shown that huge feedstock potential for conventional biofuels won't notably contribute to the balance of total primary energy supply. Taking into account recent food embargo followed by strong support of agricultural sector and economic crisis, Russia needs to continue R&D and its intentions rather in advanced biofuels sphere then in conventional, in order to have efficient diversification of energy sources and achieving settled goals.

Pushed by strong reliance on imported energy sources plans to join EU and fulfill Kyoto protocol requirements; Ukraine has managed to implement biofuel policies and programs, some of which actually proved to be efficient. As two other analyzed countries, Ukraine has been exporter of biofuel feedstock to EU for a long period. But Ukrainian attention was paid only to bioethanol production while ambitions in biodiesel industry did not succeed. Ukraine has established considerable regulatory policies and fiscal incentives in the form of tax benefits and "green" tariff; aligned by quantitative targets that have helped Ukraine to achieve 1.8% of

biofuels in the balance of TPES in 2014. But last changes in excise law in 2013 and further in 2015 have negatively affected Ukrainian biofuel sector and pushed industry into stagnation.

Based on estimations of Ukrainian exported feedstock, we came to the conclusion that potential of exported raw materials would provide country with 50% from the targeted biofuels share, planned in draft of Energy Strategy until 2035. Despite disadvantages of conventional biofuels and global trend to shift to 2nd generation, potential from the available feedstock would be sufficient for the first development stage of the industry followed by expansion to advanced biofuels energy. But low oil prices trend together with high excise tax rate hinder Ukraine from expansion of the sector and accomplishment biofuels Strategy goal.

While Ukraine or Russia did not succeeded in the projects for biodiesel production, Belarus has been developing only this type of liquid biofuel. Belarus same as Ukraine had also struggled with critical level of dependence on imported energy. Biodiesel has been presented in the balance of TPES from year 2008 and encouraged by State Program for the Production of Biodiesel for the period 2007-2010. To support the market Belarus has also set tax reliefs, nonetheless that were related only to producers. In spite of low rapeseed yield in 2010, weak domestic demand and insufficient capacities of manufactures, volume of produced biodiesel from Belarus remains stagnating and now is exported to EU. Reduction of imported energy is among the priorities for increase the efficiency of Belarusian economy. Investigated potential from exported biofuel and feedstock from Belarus would allow decrease imported energy by 5% and achieve 14% from objective of Strategy for energy potential development. However in order to accomplish set targets of Strategy, Kyoto protocol and to deal with low energy security, in the long-term Belarus would require revision of current policies and expansion of biofuel's production capacities including bioethanol production.

If analyzed countries leave biofuel sector underdeveloped, they will have to face same energy issues, whether in near future or later. But until oil prices stay on the low levels, supportive policies would not be sufficient for the growth of young industry. While in short-term biofuels could offer limited benefits and serious challenges for Russia, Ukraine and Belarus, the potential for clean energy sources, country's energy independence and efficiency is substantial.

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